K2 follow-up of the nearby, old open cluster Ruprecht 147

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Open clusters (OC) are an ensemble of stars sharing similar age and distance. OC stars are chemically homogeneous and their distances and ages can be measured with much higher precision than for field stars. Many observables, such as stellar rotation or activity, can be calibrated as a function of spectral type within a cluster, and as a function of age and metallicity using stars from several OCs. For all these reasons, OC stars are ideal targets for exoplanet search. Better than field stars, OC stars allow us to study the dependence of planet frequency as a function of metallicity, age, and environment.

Ruprecht 147 (Rup147) is an old (3 Gyr), nearby (200 pc) OC with super-solar metallicity ([Fe/H]~0.1). This OC has been recently re-discovered by Curtis et al. (2012). Because of its old age (which implies a minimal activity for its main sequence stars), its closeness (members are bright stars), and high metal content (possible higher probability for its stars to host planets), Rup147 is a quite an interesting object for the search of exoplanets in OCs. Indeed, we are already monitoring it with ESO/HARPS (13 nights allocated between 2013 and 2014; additional 8 nights scheduled for late spring 2015).

Rup147 also is an appropriate target for transit search.

Here, we propose to exploit K2 long term and continuous photometric monitoring capabilities in order to:

- Search for transiting exoplanets;

- Collect simultaneous radial velocities (RV) with HARPS and photometric observations (K2) to estimate and correct for activity effects the RV curves, such as the presence of transitory flares or RV variations induced by stellar rotation. The proposed observations will allow us to prioritize the most suitable targets and select additional candidates for the RV survey, also on the basis of their photometric stability (less active stars).

- Measure rotation periods. Rotation periods measured for single-age populations are critical for investigating how stellar angular momentum evolves over time, how that evolution depends on mass, and how rotation influences the stellar dynamo and the magnetically heated chromosphere and corona. Until now, gyrochronology characterization has only involved stars in young (<1 Gyr) OC. K2 observations of Rup147 will allow us to extend this field to intermediate-age stars.

- Identify and photometrically characterize □detached eclipsing binaries□ (dEBs). With photometry and accurate RV follow-ups it will be possible to estimate masses and radii of the individual stellar components to accuracy better that 1%, as demonstrated in Brogaard et al. (2011,2012). The location of these stars in the mass-radius plane will allow us to estimate the age and the Helium mass fraction (Y) with unprecedented accuracy. The advantage of comparing theory with observation on the mass-radius plane rather than on the traditional color-magnitude diagram (CMD) is huge. The comparison between masses and radii directly with models avoids the effects of uncertainties in distance, reddening and on the color-temperature- metallicity relations, as well as the degeneracy between ages and Y.

Our group has a huge experience on high precision stellar photometry (Piotto et al. 2013, 2015; Bedin et al. 2013, 2015) and astrometry (Bellini et al. 2009, 2010, Libralato et al. 2014), exoplanet characterization (Nascimbeni et al. 2011ab, 2013; Granata et al. 2014), and multi-year wide field surveys for search and characterization of variable stars in OCs (Nardiello et al. 2015). K2 data of Rup147 will be reduced with an independent software we have developed building up from our experience (e.g. Anderson and Bedin 2010) and alternative to Vanderburg et al. (2013) (and similar) techniques.

We have a list of 250 Rup147 members, down to V=16 that we propose to observe with K2. The detrended light curves will be released to the community.